# The ostracod genus *Loxoconcha* Sars from Abu Dhabi lagoon and the neighbouring near-shore shelf, Persian Gulf

**Raymond H. Bate & Ann Gurney**

Departments of Palaeontology and Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD

## Introduction

The present study on the genus *Loxoconcha* from the region of Abu Dhabi lagoon (Lat. 24° 32′ N, Long. 54° 27′ E), follows a number of ecological and taxonomic papers (see Bate 1971, 1973; Bate & Sheppard, 1980; and Gurney 1979*a* & *b*) that have been based on material collected by Dr Graham Evans of Imperial College, London, during the period 1961–65. This material, collected during an investigation of the Recent sediments of the Trucial coast, has been supplemented, for the ostracod studies, with samples collected by Professor John Murray (Exeter) in 1969.

Elsewhere in the Gulf, Sabeekah Razzaq (1979) has undertaken a preliminary study of the benthic microfauna of Kuwait while Paik (1976 & 1977) has examined the ostracod faunas on the Iranian side of the Gulf as well as from the Gulf of Oman. Other papers relevant to our study are those of Hartmann 1964, on ostracods from the Red Sea; Jain 1978, on the fauna of Mandvi Beach, west coast of India and Bhatia 1979, on part of the fauna from off Karwar, west coast of India.

Four species of *Loxoconcha* (*Loxoconcha*) and one of the new subgenus *Epakroconcha* are described here; it is the purpose of this paper not only to place these on record but to discuss the relevance of the ornamental differences (ranging from coarsely reticulate to finely pitted) that are exhibited between the species.

## Systematic descriptions

### Genus *LOXOCONCHA* Sars, 1866

REMARKS. In Bate *et al.* (in press), the genus *Loxoconcha* was divided into two subgenera: *Loxoconcha* and *Loxocorniculum*. Here a third subgenus *Epakroconcha* is recognized. Of the five species described from Abu Dhabi lagoon and the Persian Gulf, four belong to the subgenus *Loxoconcha*, being forms having a clear cut dimorphism of subquadrate females and subrectangular males. The fifth species differs by having a subtrigonal outline for both males and females and is accordingly placed in the separate subgenus *Epakroconcha*.

### Subgenus *LOXOCONCHA* Sars, 1866

REMARKS. The four species described here differ ornamentally by having either a reticulate or a pitted shell surface. We have grouped the species according to this and, as will be discussed under environment, we show that this has a bearing on their distribution either within the lagoon or outside on the nearshore shelf.

*Bull. Br. Mus. nat. Hist.* (Zool.) **41** (5): 235–251 Issued 17 December 1981

**Reticulate species**

***Loxoconcha (Loxoconcha) multiornata*** sp. nov.
(Figs 1A–J, 2 & 11)

*Loxoconcha ornatovalvae* Hartmann; Bate 1971 : 245, 246, 248, 250, pl. 1, figs. 1k & 2k, pl. 2, fig. 3k, pl. 3, figs. 2k & 3k.
*Loxoconcha* sp. A, Jain 1978 : 126, fig. 5A.

HOLOTYPE. BM(NH) no. 1980.236, ♂ carapace, sample 6514, central lagoon terrace.

PARATYPES. BM(NH) nos 1980.237–243.

TYPE LOCALITY. Sample 6514—Central lagoon terrace, shallow marine, tidal; salinity 50·75‰.

DIAGNOSIS. Species of *Loxoconcha* having very coarsely reticulate ornamentation (as illustrated) with some reticulae developed into ridges; dorsal ridge of carapace characteristically producing pear-shaped pattern.

DESCRIPTION. Species dimorphic, the males more elongate than the females. Ornamentally the reticulae are very coarsely developed and may even be produced as low ridges. The eye node is developed as a swelling situated on a low antero-dorsal ridge. Sieve plate normal pores are situated within the reticulae. Ventrally, the edge of the right valve, where it overlaps the left, is marked with short ridges while the left valve in the posterior part of the carapace possesses four rowlock-type projections (Fig. 1D). Hinge typically gongylodont with coarsely dentate/loculate median element. Muscle scars with three oval adductor scars in a vertical row with a fourth situated almost in front of the lowermost scar. Frontal scar V-shaped. Duplicature broad with small antero-ventral and narrow postero-ventral vestibule. Marginal canals straight, widely spaced and few in number: 9 anteriorly. Outside the selvage a broad flange extends around the anterior and along the ventral margin.

DIMENSIONS. Holotype: 1980.236 ♂ carapace, length 0·46 mm; height 0·26 mm; width 0·26 mm. Paratypes: 1980.237 ♂ RV., length 0·47 mm; height 0·26 mm. 1980.238 ♀ carapace, length 0·38 mm; height 0·24 mm; width 0·23 mm. 1980.239 ♀ carapace, length 0·40 mm; height 0·25 mm; width 0·23 mm. 1980.240 ♂ carapace, length 0·50 mm; height 0·26 mm; width 0·28 mm. 1980.241 ♀ RV., length 0·40 mm; height 0·24 mm. 1980.242 ♂ RV., length 0·44 mm; height 0·25 mm.

REMARKS. *Loxoconcha (Loxoconcha) multiornata* sp. nov. is morphologically very close to the Red Sea species, *Loxoconcha ornatovalvae* Hartmann 1964 and was, in fact, identified as such by one of us (Bate, 1971). There are, however, significant differences that make separation of the two species possible: firstly in dorsal view, the curved dorsal ridge of *L. multiornata* produces a pear-shaped pattern when both valves are together (Fig. 1E, F) whereas in *L. ornatovalvae* (Hartmann, 1964, pl. 20, fig. 93) there is a looped ridge pattern extending from the eye node back along the dorsal margin. The eye node of the Red Sea species is separate from the antero-dorsal ridge, whereas in *L. multiornata* it is a swollen part of the ridge. The differences in the lateral ornamentation are best explained by illustration (see Fig. 2).

*Loxoconcha (L.) multiornata* has been recorded by Jain 1978 as *Loxoconcha* sp. A from the Recent sediments of Mandvi Beach, west coast of India and is thus known to occur within the Indian Ocean area. As yet it has.not been recorded from the African coast. If, as appears possible, the Red Sea *Loxoconcha ornatovalvae* has developed from the Indian Ocean/Persian Gulf *L. multiornata*, then we are going some way to implying that species give rise to similarly ornamented species and this could lead us to a subdivision of the subgenus *Loxoconcha* on basic external morphology. By grouping the five species described in this paper on similar ornamentation we are partly suggesting this but we would not claim that the groupings here necessarily relate to all the species described here.

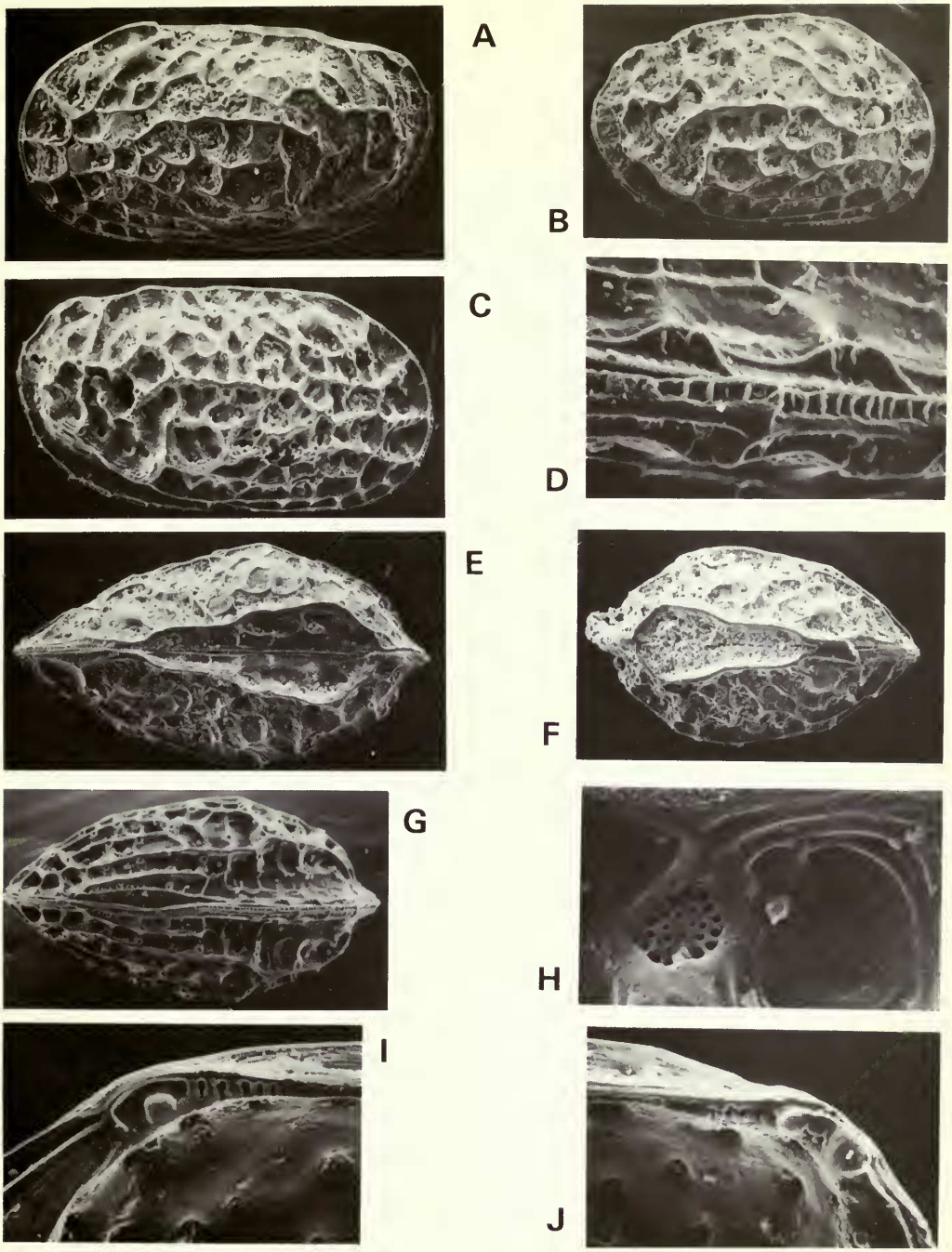


**Fig. 1** *Loxoconcha (Loxoconcha) multiornata* sp. nov.: A, X 125, holotype, ♂ left side, BM(NH) 1980.236; B, X 125, paratype ♀ RV., specimen lost; C, X 125, paratype ♂ RV., BM(NH) 1980.237; D, G, enlargement of ventral margin X 580 and ventral view of carapace X 125, ♀ paratype BM(NH) 1980.239; H, X 1·12K, sieve plate, specimen lost; E, X 125, paratype ♂ dorsal carapace, BM(NH) 1980.240; F, X 125, paratype ♀ dorsal carapace, BM(NH) 1980.239; I, J, X 345, paratype ♀ terminal hinge elements RV, BM(NH) 1980.241.

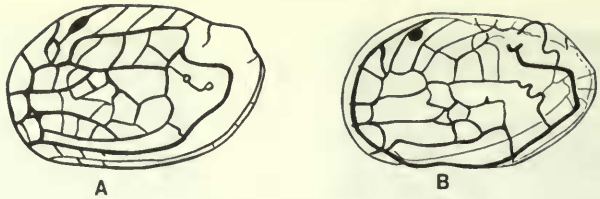


**Fig. 2** Comparison of ornamentation between *Loxoconcha (Loxoconcha) multiornata* sp. nov. [A] and *Loxoconcha (Loxoconcha) ornatovalvae* Hartmann [B].

DISTRIBUTION. *Loxoconcha (L.) multiornata* is essentially a nearshore shelf species but does occur sporadically in the inner, central and outer lagoon areas (Fig. 11).

***Loxoconcha (Loxoconcha) gurneyi*** sp. nov.
(Figs 3A–K, 4 & 11)

*Loxoconcha* sp. A. (pars), Bate 1971 : 245, 246, 248, pl. 1, figs 11, 21, pl. 2, figs 21, 31 & pl. 3, figs 11, 21 & 31.
*Loxoconcha* sp. B., Jain 1978 : 126, fig. 5B.

DERIVATION OF NAME. Named in honour of Dr Robert Gurney, 1879–1950, Zoologist, well known for his work on Crustacea.

HOLOTYPE. BM(NH) no. 1980.245, ♂ LV. sample 62107, nearshore shelf.

PARATYPES. BM(NH) nos 198.246–251 & 431.

TYPE LOCALITY. Sample 62107, nearshore shelf; shallow marine; salinity 43·75‰; surface water temperature 23·0–24·4°C.

DIAGNOSIS. Species of *Loxoconcha* with neat, honeycomb reticulation.

DESCRIPTION. Carapace quadrate (♀) to rectangular (♂) with straight dorsal margin; sinuous ventral margin; broadly rounded anterior and posteroventral margins; posterodorsal margin short and concave. Eye node oval, situated below anterior cardinal angle. Entire shell surface covered by neat reticulation of somewhat rounded, 5-sided, pits; the pits becoming 4-sided around the posterior margin and along the dorsal and ventral surfaces. Ventral margin of right valve ornamented by short ridges situated perpendicular to valve edge (Fig. 3B). Normal pore canals open, through a sieve plate, on the murae of the reticulation. Hinge, well developed gongylodont. Muscle scars with a vertical row of 4 adductors and an oval frontal scar (Fig. 3G). Duplicature broad around anterior (with a narrow vestibule) and in the posteroventral region; eight long, straight and widely spaced anterior canals. A distinct flange extends around the entire free margin. Copulatory appendage with small, blunt-ended, lappet (Fig. 4).

DIMENSIONS. Holotype: 1980.245, ♀ carapace, length 0·50 mm; height 0·29 mm; width 0·27 mm. Paratypes: 1980.246, ♂ LV., length 0·53 mm; height 0·28 mm. 1980.247, ♂ RV., length 0·52 mm; height 0·28 mm. 1980.248, ♂ RV., length 0·49 mm; height 0·27 mm. 1980.249, ♀ carapace, length 0·49 mm; height 0·31 mm; width 0·25 mm. 1980.250, ♂ LV., length 0·53 mm; height 0·29 mm.

REMARKS. *Loxoconcha (L.) gurneyi* sp. nov. has previously been figured as *Loxoconcha* sp. A. by Bate from the Persian Gulf and as *Loxoconcha* sp. B. by Jain from Mandvi Beach, west coast of India. *Loxoconcha gruendeli* Jain 1978 from Mandvi beach is very close to this species but differs by having pits rather than reticulae in the dorsal region and by having a smooth posterior border; in *L. (L.) gurneyi* short ridges cross the posterior border. Like *L. (L.) multiornata,* a series of short ridges occur along the free outer margin of the ventral edge of the right valve (Fig. 3B, D). A number of individual valves completely lack a duplicature

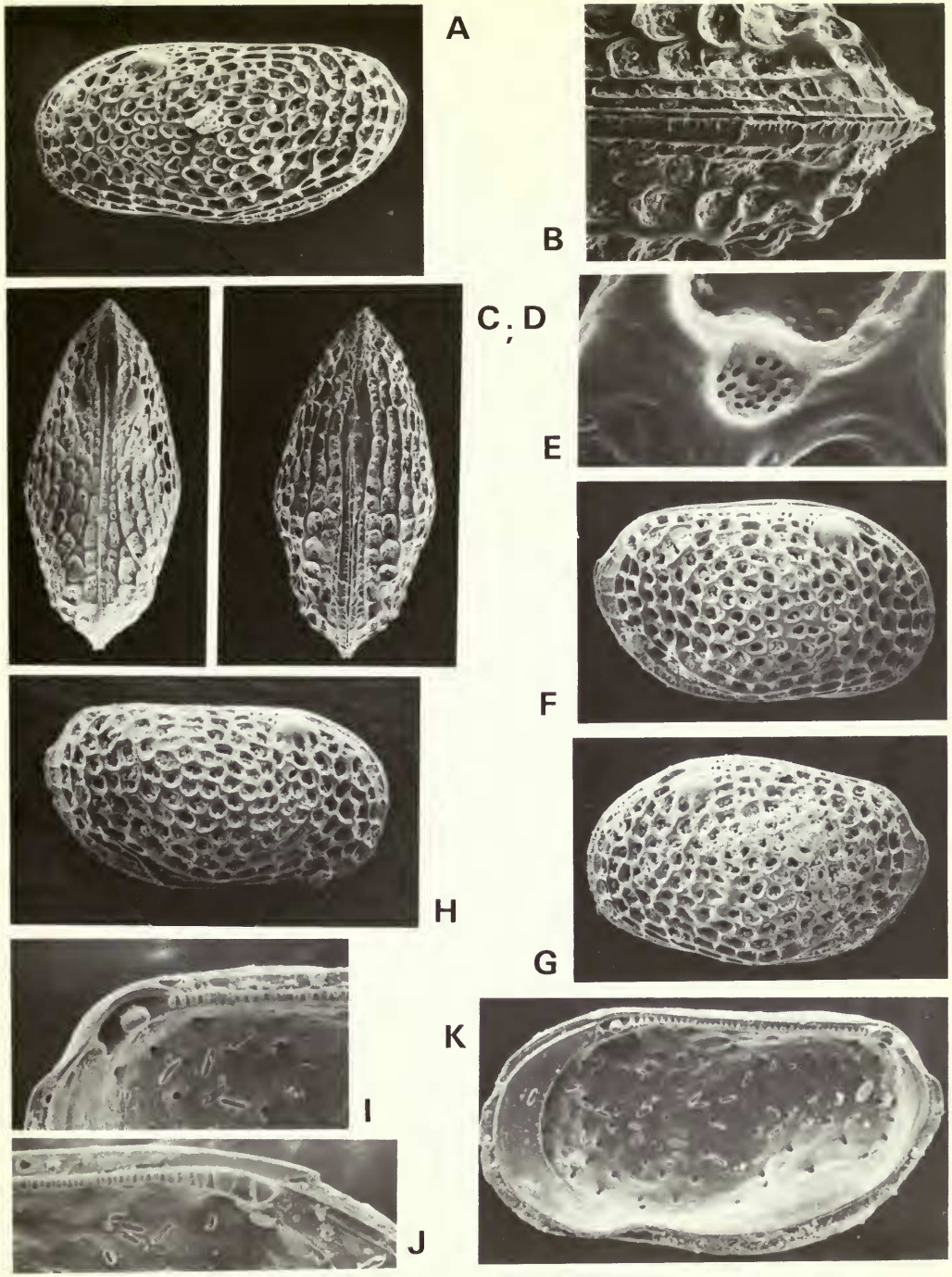


**Fig. 3** *Loxoconcha (Loxoconcha) gurneyi* sp. nov.: A, E, LV. X 100 and sieve plate X 600, ♂ holotype BM(NH) 1980.250; B, D, enlarged view posteroventral margin X 200 and ventral surface X 100 ♂ carapace, specimen lost; C, X 100, paratype ♂ dorsal carapace, specimen lost; F, X 100, paratype ♀ left carapace, BM(NH) 1980.249; G, X 100, holotype ♀ right carapace, BM(NH) 1980.245; H, X 100, paratype ♂ RV., BM(NH) 1980.248; I, J, X 250, paratype ♂ terminal hinge elements RV., BM(NH) 1980.246; K, X 125, paratype ♂ internal RV., BM(NH) 1980.247.

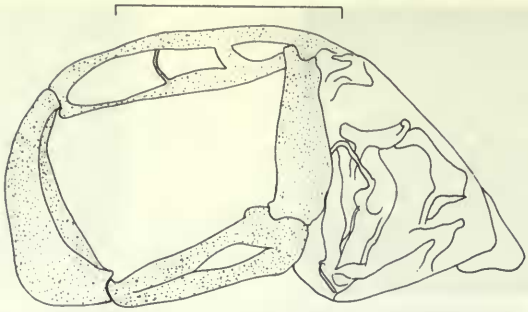

**Fig. 4** Copulatory appendage of *Loxoconcha (Loxoconcha) gurneyi* sp. nov. ♂ paratype BM(NH) 1980.431. Scale bar represents 0·1 mm.

(e.g. BM(NH) no. 1980.250)—this is considered to be due to the animal dying immediately after moulting and before calcification of the duplicature part of the inner lamella.

DISTRIBUTION. *Loxoconcha (L.) gurneyi* sp. nov. is a nearshore shelf species in the Persian Gulf—its presence in Abu Dhabi lagoon (Fig. 11) was almost certainly the result of being taken into the lagoon by tidal currents.

**Pitted species**

***Loxoconcha (Loxoconcha) indica*** Jain, 1978
(Figs 5A–H & 11)

*Loxoconcha* sp. C., Bate 1971 : 246, 250, pl. 3, figs. 2n, 3n.
*Loxoconcha megapora indica* n. subsp. Jain 1978 : 126, figs. 4L 1–2; 6P.

TYPE LOCALITY. Mandvi beach, west coast of India.

DIAGNOSIS (emended). Small species of *Loxoconcha* having densely pitted surface ornamentation. Posteroventral margin of carapace broadly convex; posterior end broadly rounded with short, weakly concave, posterodorsal margin. Carapace convex in dorsal view; eye nodes distinct.

DESCRIPTION. Carapace dimorphic, males rectangular, females quadrate; both sexes with broadly rounded anterior and posterior ends, posterodorsal margin being short and insignificantly concave. Eye node distinct. Shell surface covered by a dense, finely pitted ornamentation, smooth patches medianly and dorsally marking the location of muscles on the inside of the shell. Periphery of carapace with very fine network of striae. Normal pores open to exterior by means of a sieve plate. Left valve larger than right. Hinge gongylodont, muscle scars a subvertical row of 4 oval scars with a crescent-shaped anterodorsal frontal scar and two, large, rounded, anteroventral mandibular scars. Duplicature of moderate width with a distinct vestibule extending around the anterior end; anterior marginal canals long, straight and widely spaced; approximately 9–10 anteriorly.

DIMENSIONS. 1980.252, ♂ carapace, length 0·49 mm; height 0·26 mm; width 0·23 mm. 1980.253, ♀ LV., length 0·42 mm; height 0·26 mm. 1980.254, ♂ carapace, length 0·48 mm; height 0·26 mm; width 0·23 mm. 1980.255, ♀ RV., length 0·41 mm; height 0·26 mm. 1980.256, ♀ carapace, length 0·43 mm; height 0·27 mm; width 0·22 mm.

REMARKS. *Loxoconcha (L.) indica* Jain, 1978 was first described as a subspecies of *L. megapora* Benson & Maddocks, 1964 by Jain from Mandvi beach, west coast of India. *L. megapora*, a smooth species found in the Knysna estuary, South Africa has a different dorsal outline (being parallel-sided to slightly concave) to Jain's material and the two are not considered to be conspecific. Jain's subspecies is, therefore, raised to specific status.

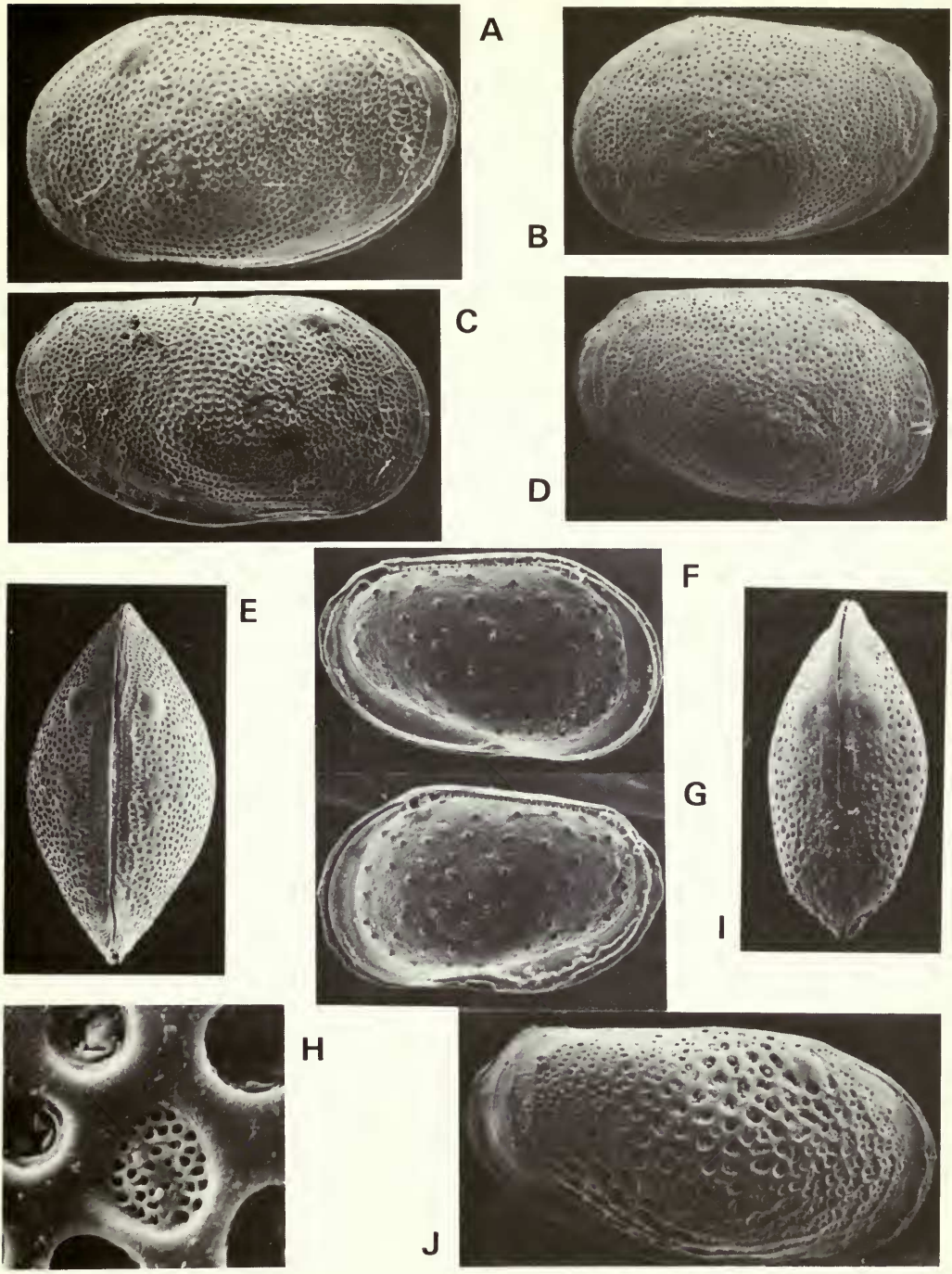


**Fig. 5** *Loxoconcha (Loxoconcha) indica* Jain. A, H, ♂ left carapace X 125 and sieve plate X 750, BM(NH) 1980.252; B, F, ♀ LV. X 125 and internal view X 100, BM(NH) 1980.253; C, X 125, ♂ right carapace, BM(NH) 1980.254; D, G, external view X 125 and internal view, X 100, ♀ RV. BM(NH) 1980.255; E, X 125, dorsal view, ♀ carapace BM(NH) 1980.256. *Loxoconcha (Loxoconcha) amygdalanux* sp. nov. I, X 125, paratype dorsal carapace –2 instar, BM(NH) 1980.257; J, X 118, holotype ♂ RV. BM(NH) 1980.258.

*Loxoconcha* sp. C. recorded by Bate, 1971 from Abu Dhabi lagoon, Persian Gulf is considered to be conspecific with Jain's *L. indica* even though the postero-ventral margin of the Persian Gulf material is more broadly convex; the geographical range of the species is thus extended. Laterally *L. indica* has a superficial resemblance to *L. matagordensis* Swain, 1955 from San Antonio Bay, Texas but lacks the posterodorsal *Loxocorniculum* projection, anterior marginal ridges and oblique anterodorsal slope of *matagordensis*. Ornamentally, there are many species, including *L. rhomboidea*—the type species, that possess the type of ornamentation exhibited here; carapace outline differences as well as the male copulatory appendage being used to distinguish between them. Unfortunately although females with appendages occur for *L. indica* no male was available for dissection. *Loxoconcha* spec. illustrated by Hartmann (1980, pl. 10, figs. 14, 15) from Pt. Welshpool, Australia is comparable in shape with *L. indica* although lacking the straight dorsal margin of the latter and having a much more finely pitted ornamentation.

DISTRIBUTION. Mandvi Beach, west coast India and in the Persian Gulf where it occurs on the shallow terraces of Abu Dhabi lagoon having a salinity tolerance of 44·80–55·30‰ and a surface water temperature of 20–36·2°C; so far only found allochthonously on the nearshore shelf.

### ***Loxoconcha (Loxoconcha) amygdalanux*** sp. nov.
(Figs 5, I, J; 6, A–K; 7; 8, A–C & 11)

*Loxoconcha* sp. B., Bate 1971 : 245, 246, 248, pl. 1, fig. 2 m; pl. 2, fig. 3 m.
*Loxoconcha* sp. A., Paik 1977 : 56, 58, pl. 6, figs. 112–114.

DERIVATION OF NAME. Latin *amygdala*, almond + *nux*, a nut.

HOLOTYPE. BM(NH) no. 1980.258, ♂ RV., sample 6278, back reef, nearshore shelf.

PARATYPES. BM(NH) nos 1980.257 & 259–263, 269 & 430.

TYPE LOCALITY. Sample 6278 nearshore reef; salinity gradient 43·05–44·45‰; surface temperature 23·0–33·6°C.

DIAGNOSIS. Coarsely pitted species of *Loxoconcha* in which pits are larger towards centre of valve. Dimorphism distinct: females subquadrate, males rectangular. Posteroventral border broadly convex in female, less so in male. Male with distinct postero-ventrolateral carapace indentation. Copulatory appendage shovel-shaped with small, triangular, terminally pointed lappets.

DESCRIPTION. Carapace quadrate with broadly rounded anterior margin and deep, convex posteroventral margin and straight to slightly convex dorsal margin in the female. Male very elongate with rounded anterior and deep depression in posterior ventrolateral surface. Eye nodes in both dimorphs distinct. Ornamentation of large pits more evenly sized in the female. In the male the pits are very much larger towards the centre of each valve. Normal pore sieve plates situated on broad murae between pits. Left valve only slightly larger than right, almost equivalve. In ventral view female carapace has appearance of an almond, from which the species name has been taken. Internally the hinge is well developed, gongylodont. Muscle scars a curved row of four adductors, an anterocentral crescent-shaped frontal scar and two oval anteroventral mandibular scars. Duplicature broad with narrow anterior and posteroventral vestibules. 9 anterior marginal canals, long, straight and widely spaced. Copulatory appendage shovel-shaped with small, triangular, terminally pointed lappets.

DIMENSIONS. Holotype: 1980.258, ♂ RV., length 0·57 mm; height 0·30 mm. Paratypes: 1980.257, –2 instar, carapace, length 0·38 mm; height 0·22 mm; width 0·19 mm. 1980.259, ♂ LV., length 0·58 mm; height 0·29 mm. 1980.260, –2 instar, carapace, length 0·40 mm; height 0·26 mm; width 0·22 mm. 1980.261, –2 instar, LV., length 0·34 mm; height 0·19 mm. 1980.262, ♀ RV., length 0·49 mm; height 0·30 mm. 1980.263, ♀ RV., length 0·43 mm; height

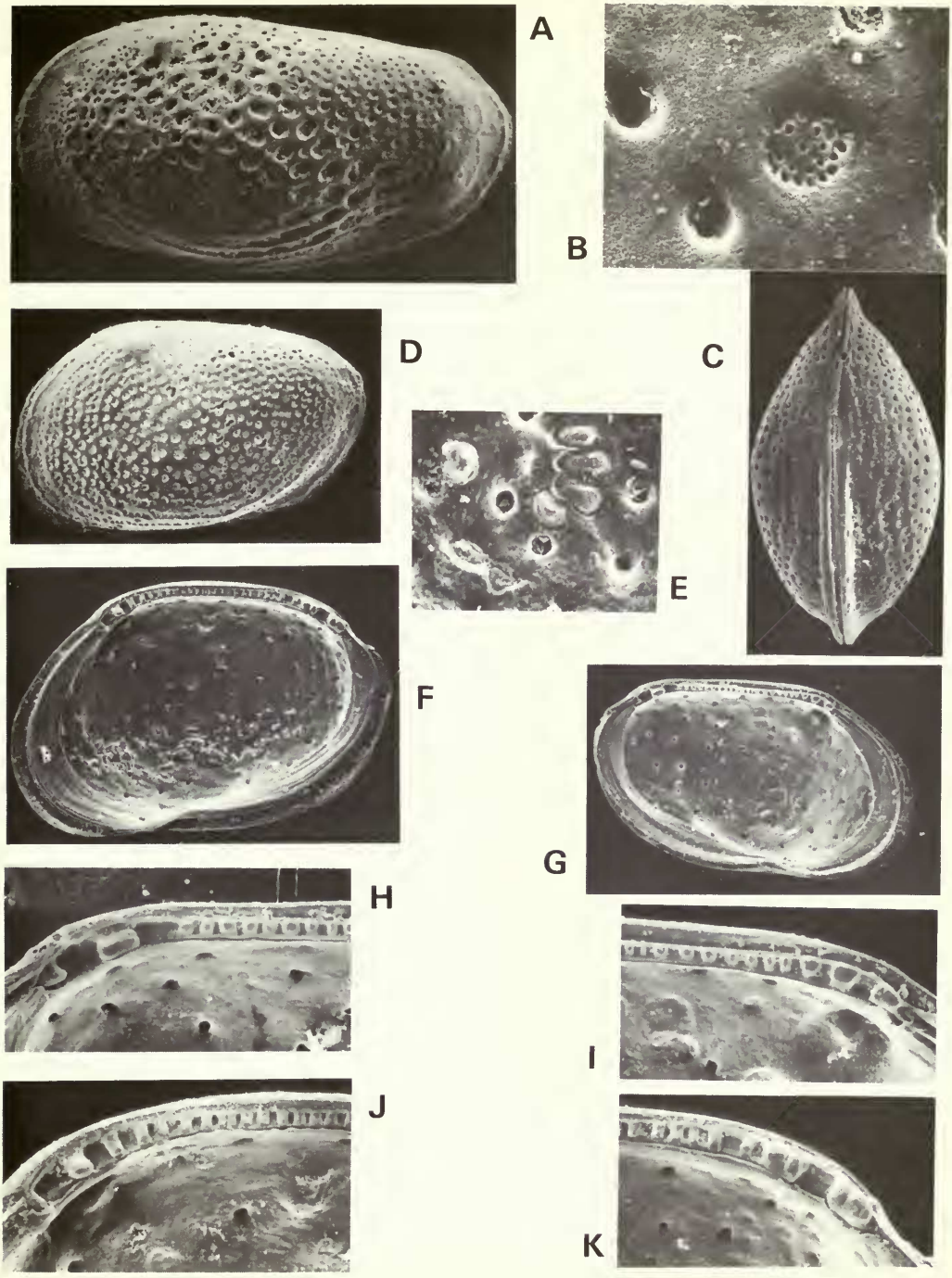


**Fig. 6** *Loxoconcha (Loxoconcha) amygdalanux* sp. nov.: A, X 122, paratype ♂ LV., BM(NH) 1980.259; B, D, sieve plate X 1·05K and external view X 125 –2 instar LV, paratype BM(NH) 1980.261; C, X 127, paratype ventral carapace –2 instar, BM(NH) 1980.260; E, X 260 muscle scars paratype ♀ RV, BM(NH) 1980.262; F, J, K, internal view X 123 and terminal hinge elements X 265, female RV., paratype BM(NH) 1980.263; G, H, I, internal view X 122 and terminal hinge elements X 350, –2 instar LV., paratype BM(NH) 1980.264.

Fig. 7 Copulatory appendage of *Loxoconcha (Loxoconcha) amygdalanux* sp. nov. ♂ paratype, BM(NH) 1980.430. Scale bar represents 0·1 mm.

0·27 mm. 1980.264, –2 instar, LV., length 0·40 mm; height 0·22 mm. 1980.265, –2 instar, RV., length 0·38 mm; height 0·22 mm. 1980.266, –1 instar, RV., length 0·41 mm; height 0·26 mm. 1980.267, –2 instar, LV., length 0·37 mm; height 0·24 mm.

Remarks. *Loxoconcha (L.) amygdalanux* sp. nov. has been recorded from the Gulf of Oman and the Persian Gulf by Paik (1977) who records this species from his faunal zones A to C, open marine conditions ranging in depth from 7 to 208 metres. The coarse ornamentation, particularly towards the centre of the carapace, in association with carapace outline clearly sets this species apart from all others described from the Gulf/Indian Ocean region. Neither has any comparable species been described by Hartmann from the Red Sea nor Australia.

Distribution. Nearshore shelf and outer lagoon channels, Abu Dhabi lagoon; Central Basin Persian Gulf and Biaban Shelf, Gulf of Oman.

## Subgenus ***EPAKROCONCHA*** nov.

Derivation of name. Greek *epakros*, pointed at the end + *concha*, Latin, shell.

Gender. Feminine.

Type species. *Epakroconcha batei* sp. nov.

Diagnosis. Carapace subtrigonal in lateral outline of both dimorphs with left valve dorsal margin umbonate; right valve dorsal margin almost straight. Left valve larger than right. Eye node distinct. Normal pore canals with sieve plate. Shell surface ornamented. Hinge gongylodont. Muscle scars with 4 oval adductors, a crescent-shaped frontal and an oval anteroventral mandibular. Anterior and posteroventral duplicature broad with vestibula and straight marginal canals, few in number. First antenna long, slender, 6 jointed with 4 terminal bristles. 2nd antenna with two terminal claws and long spinneret bristle. Maxilla with small comb of spines on inner (1st) endite and having approx. 16 (one aberrant) bristles on respiratory plate. Walking legs slender. Copulatory appendage boot-shaped with small terminally rounded lappet.

Remarks. *Epakroconcha* subgen. nov. differs from other loxoconchid genera by having a subtrigonal shell outline in both dimorphs; the male being only slightly more elongate than the female.

### ***Loxoconcha (Epakroconcha) batei*** sp. nov.
(Figs 8, D–H; 9, A–C; 10 & 11)

Derivation of name. Named in honour of Charles Spence Bate 1818–1889 for his work on Recent crustacea.

Holotype. BM(NH) no. 1980.271, ♂ carapace, sample 1094, central lagoon terrace.

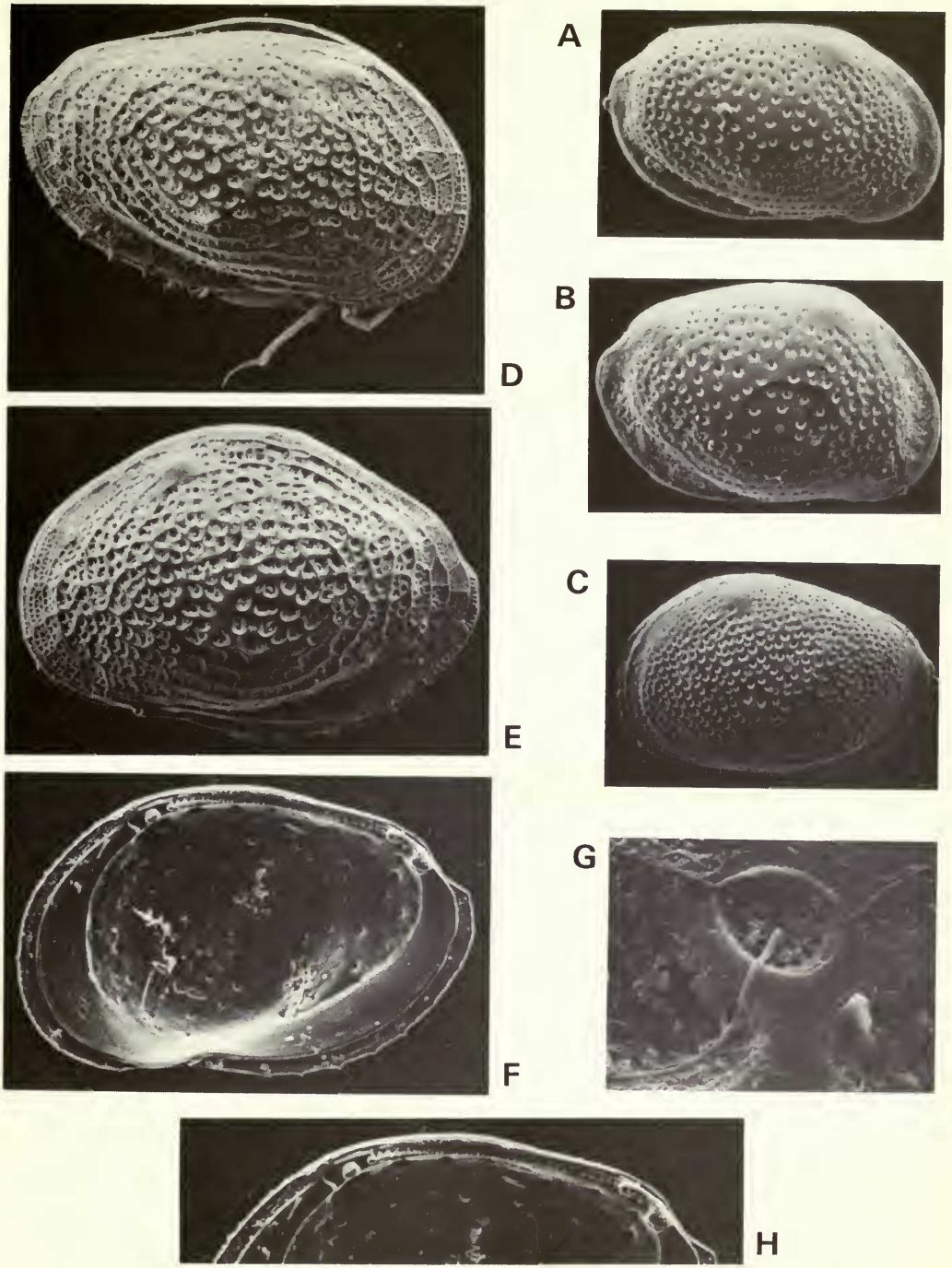


**Fig. 8** *Loxoconcha (Loxoconcha) amygdalanux* sp. nov.: A, X 126, RV., –2 instar, paratype BM(NH) 1980.265; B, X 118, RV., –1 instar, paratype BM(NH) 1980.266; C, X 122, LV., –2 instar, paratype BM(NH) 1980.267. *Loxoconcha (Epakroconcha) batei* subgen. et sp. nov.: D, X 124, paratype ♂ right carapace, BM(NH) 1980.268; E, X 137, paratype ♀ left carapace, BM(NH) 1980.269; F, H, internal view X 132 and hinge X 146, ♀ RV., paratype BM(NH) 1980.270; G, X 2K, holotype ♂, sieve plate, BM(NH) 1980.271.

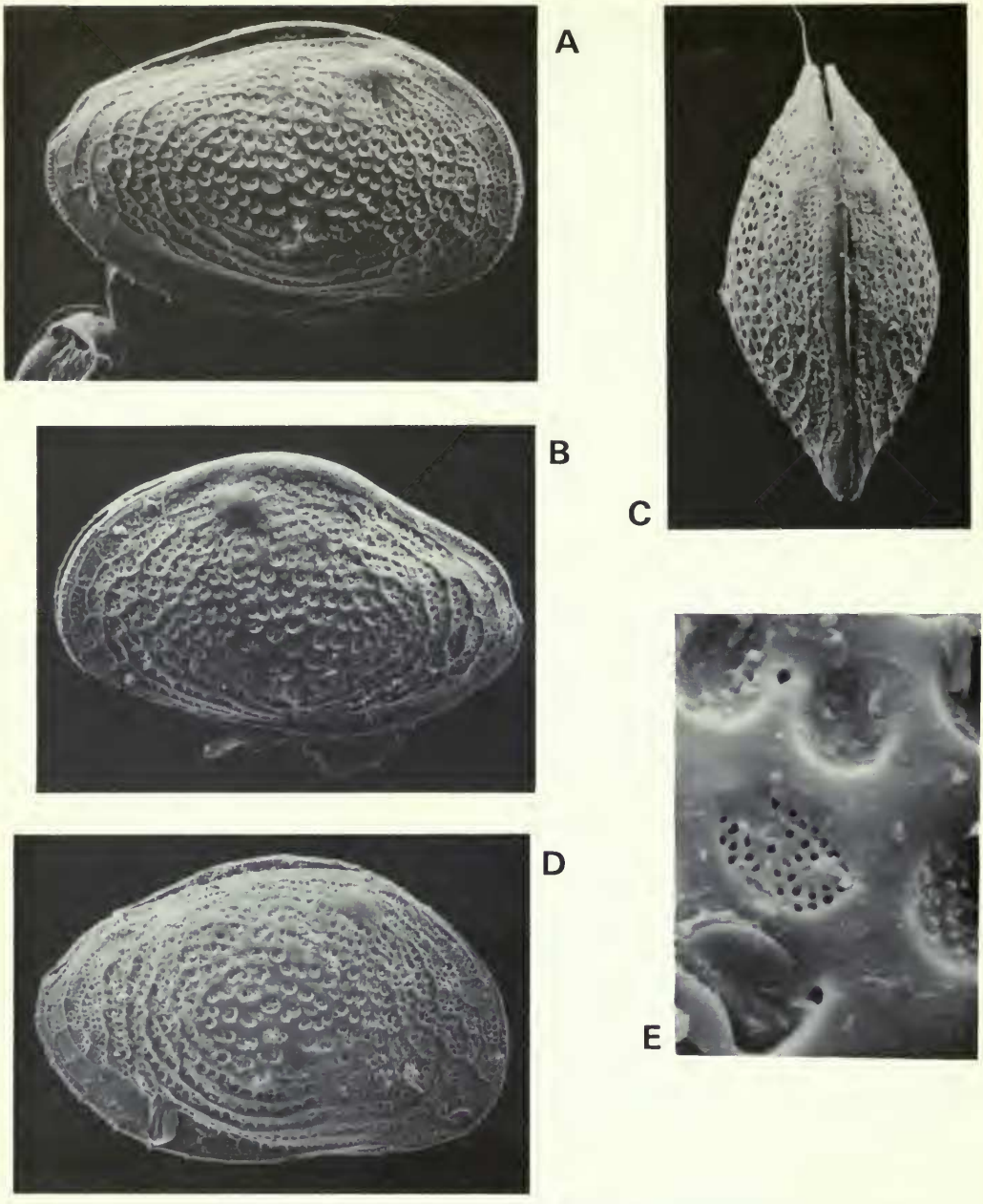


**Fig. 9** *Loxoconcha (Epakroconcha) batei* subgen. et sp. nov.: A, X 127, holotype ♂ right carapace, BM(NH) 1980.271; B, X 121, paratype ♂ left carapace, BM(NH) 1980.272; C, X 122, paratype ♀ dorsal carapace, BM(NH) 1980.273. D, X 125, paratype ♀ right carapace, BM(NH) 1980.428. E, X 1·8K, sieve plate, paratype ♀ right carapace, BM(NH) 1980.428.

---

**Fig. 10** *Loxoconcha (Epakroconcha) batei* subgen. et sp. nov. Appendages and copulatory organ. Scale A—0·1 mm for appendages; scale B—0·1 mm for copulatory organ. A, F, 1st antenna and copulatory organ, ♂ paratype, BM(NH) 1980.433; B, C, D, 2nd antenna, mandible and maxilla, ♀ paratype, BM(NH) 1980.432; E, 1st, 2nd & 3rd thoracic appendages, ♀ paratype, BM(NH) 1980.429.

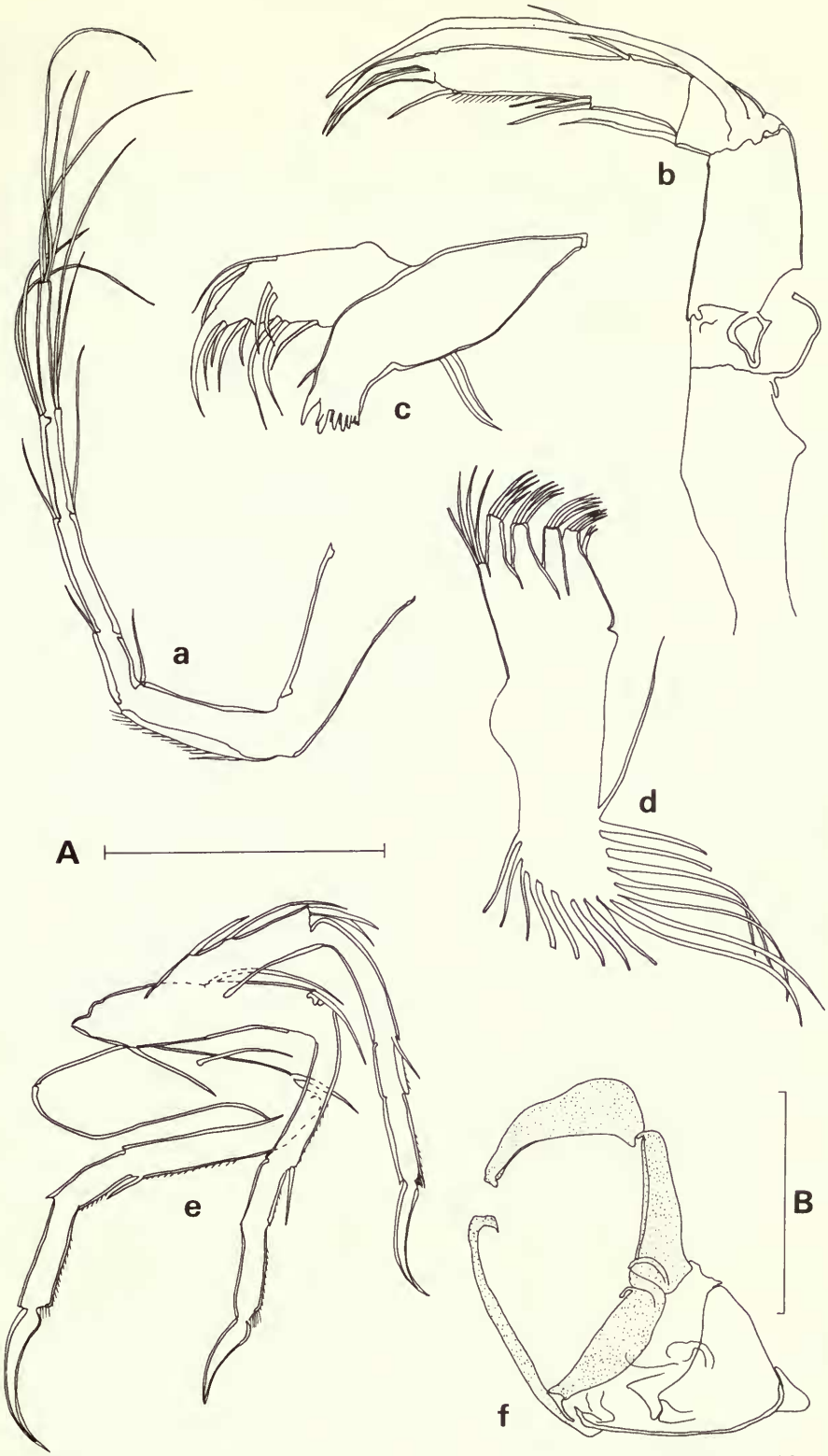


**Fig. 10** *Loxoconcha (Epakroconcha) batei* subgen. et sp. nov. Caption p. 246.

PARATYPES. BM(NH) nos 1980.268–270, 272–273, 428–9 & 432–3.

TYPE LOCALITY. Sample 1094, weed sample preserved in alcohol, inner lagoon terrace. Shallow water marine, tidal; salinity gradient 49·70–55·3‰; surface temperature of 20·5–36·2°C.

DIAGNOSIS. Species of *Epakroconcha* having coarsely pitted shell ornamentation, the pits larger towards centre of each valve. Periphery of carapace with fine network of striae. Posteroventral border of right valve with five small marginal denticles; denticles smaller and sometimes fewer in left valve. Small tubercle present on ventrolateral part of shell just below mid point, more clearly seen in dorsal or ventral view. Approximately 8 straight anterior marginal canals; 3 posterior canals. Copulatory appendage boot-shaped with small rounded-triangular lappet.

DESCRIPTION. Carapace subtrigonal in lateral outline; dorsal margin umbonate in the left valve. Anterior margin of both valves rounded; posterior with deep, convex posteroventral margin and short concave, posterodorsal margin. Left valve over-reaches right along dorsal margin. Males slightly more elongate than females. Eye node distinct; shell surface coarsely ornamented with large pits that decrease in size towards valve margins in which region a reticulation of low ridges (peripherally striae) are superimposed. A low tubercle is developed below mid-point on each valve, more clearly observed in dorsal or ventral view. Posteroventral margin with five, small, marginal denticles. Normal pores with slightly recessed sieve plate each bearing a central setal pore: setae long and slender. Hinge gongylodont. Muscle scars with an oval to crescent-shaped frontal scar situated medially in front of 4 oval adductor scars, mandibular scar elongate-oval, situated well below adductors. Duplicature broad, with broad anterior and posterior vestibula; marginal canals short, straight, approximately 8 anteriorly, 3 posteriorly and 6 posteroventrally. 1st antenna long, slender, 6 jointed with 4 slender terminal bristles and 4 bristles at distal end of penultimate podomere. 2nd antenna with two strong terminal claws and long spinneret bristle; terminal two podomeres fused. Mandible with strong masticatory process. Maxilla with blade-like respiratory process having 16 bristles (or less) of which one is aberrant. Thoracic limbs slender with strong terminal claws. Copulatory appendage boot-shaped with small, terminally rounded lappet.

DIMENSIONS. Holotype: 1980.271 ♂ carapace, length 0·52 mm; height 0·32 mm; width 0·23 mm. Paratypes: 1980.268 ♂ carapace, length 0·51 mm; height 0·31 mm; width 0·24 mm. 1980.269, ♀ carapace, length 0·49 mm; height 0·34 mm; width 0·25 mm. 1980.270, ♀ RV., length 0·50 mm; height 0·32 mm. 1980.272 ♂ carapace, length 0·52 mm; height 0·31 mm; width 0·26 mm. 1980.273 ♀ carapace, length 0·50 mm; height 0·33 mm; width 0·26 mm. 1980.428 ♀ carapace, length 0·52 mm; height 0·35 mm; width 0·25 mm. 1980.429 ♀ RV., length 0·49 mm; height 0·29 mm.

REMARKS. *Loxoconcha (Epakroconcha) batei* sp. nov. is readily separable from previously described species of the genus on its subtrigonal lateral outline and spinose posteroventral margin.

DISTRIBUTION. Inner lagoon and lagoon channels, Abu Dhabi lagoon. Transported as dead valves onto the nearshore shelf.

## Environment

It is popularly regarded that the strength of the carapace ornamentation of an ostracod is a direct reflection on the nature of the environment in which the species lives. A coarse ornament reflects an adaptation to survival within a high energy environment and a poorly ornamented shell is suitable for quieter low energy environments. This does not necessarily hold true for burrowing forms nor for those that are able to shelter within dense patches of weed or among growing coral communities. Also many genera are totally smooth for all their

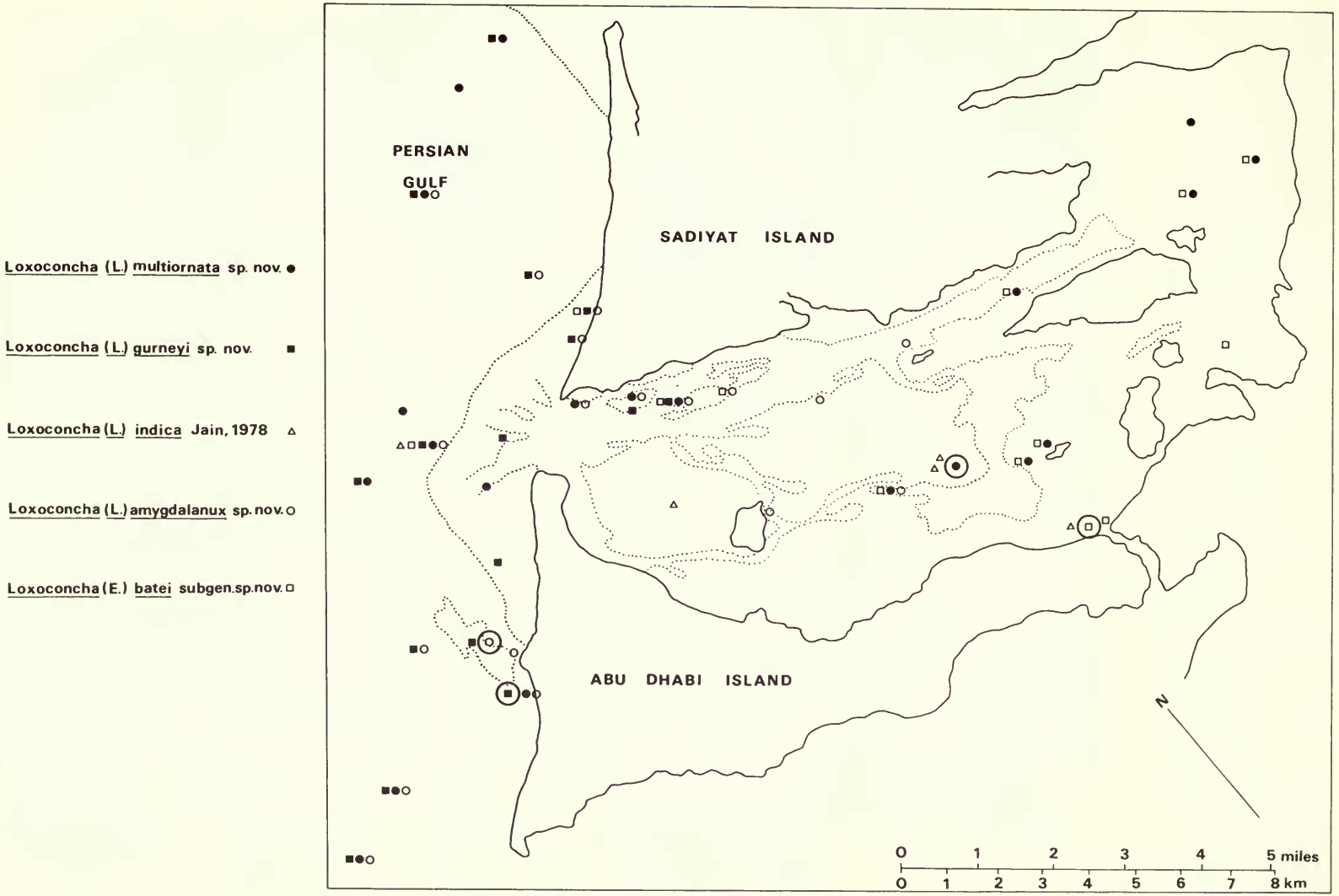


**Fig. 11** Distribution of the *Loxoconcha* species. Type localities of new species circled.

species; strength of their shell possibly being effected by their shape, for example, the rather rotund genus *Xestoleberis*. Here, all the species described live on weed or in algae on lagoon terraces, within lagoon channels or on the more open nearshore shelf environment, and as such are subjected to the considerable tidal influences of the region. For details of the oceanography of the region the reader is referred to Evans *et al.* 1973 from which the following information has been taken:

| | |
|---|---|
| Tides | –maximum rise of 2·5 m in front of the islands to 1 m at the back of the lagoon—except during periods of prolonged onshore winds. |
| Water depth | –up to 7 m deep in the lagoon channels and rarely exceeding 2 m on the lagoon terraces; often becoming dry at low tide. |
| Salinity | –nearshore waters range from 42·7‰ to 44·5‰: lagoon waters range from 53·6‰ to 66·9‰. Higher values have been recorded from tidal pools but no species of *Loxoconcha* or of *Epakroconcha* have been obtained from these high salinity (77·4‰) pools. |
| Temperature | –nearshore waters have a surface temperature of 23–24°C while lagoon waters range from 22–36°C. |

***Loxoconcha (Loxoconcha) multiornata*** sp. nov. (Fig. 11). This species of *Loxoconcha* is the most coarsely ornate of those present in our material. It is both a common nearshore shelf species and at the same time a common inhabitant of the more quiet higher salinity waters of the lagoon where it occurs both on the terraces and within the lagoon channels. This species thus shows no special preference for a particular environment. We did not, however, find any live specimens of *L. (L.) multiornata* and because of this there is a possibility that at least part of its distribution is due to postmortem dispersal. We consider that this would only be partially responsible for the distribution of the species as such a wide dispersal has not been observed for the other species.

***Loxoconcha (Loxoconcha) gurneyi*** sp. nov. (Fig. 11). This species falls into the pattern of distribution expected of an ornate ostracod. The distribution of *L. (L.) gurneyi*, either as live specimens or dead valves, is restricted to the nearshore shelf environment. The presence of individuals just inside the mouth of the lagoon as well as on the tidal delta is to be expected through simple dispersal in a particularly high energy environment of both living and dead material. *L. (Loxoconcha) gurneyi* has also been recorded from beach sediments off the west coast of India by Jain (1978) see synonymy.

***Loxoconcha (Loxoconcha) indica*** Jain (Fig. 11). A finely pitted species, *L. (L.) indica* is considered to be restricted solely to a lagoon environment. Live specimens have only been obtained from within Abu Dhabi lagoon where it lives on the outer and central lagoon terraces. It is not a common ostracod and the presence of a small number of dead valves on the nearshore shelf—significantly opposite the lagoon entrance—is considered to be due to postmortem dispersal. The original description of this species from beach sand from Mandvi, west coast India, is regarded as not being the true habitat for live specimens.

***Loxoconcha (Loxoconcha) amygdalanux*** sp. nov. (Fig. 11). This species, like *L. (L.) indica,* is pitted but rather coarsely so. Indeed the intensity of the ornamentation is reflected by the dispersal of the species being equally dominant both on the nearshore shelf and within the channels and terraces of the outer and inner lagoon. The species has also been recorded by Paik (1977) from the Central Basin, Persian Gulf and from the Gulf of Oman. *L. (L.) amygdalanux* is thus considered to be tolerant of both high and low energy environments as well as tolerating a range of salinity and temperature gradients.

***Loxoconcha (Epakroconcha) batei*** sub. gen. et sp. nov. (Fig. 11). The recorded distribution here represents our total knowledge of this species. Although live specimens were restricted to sample 1094, the type locality, the distribution of the species is not considered to be far removed from that shown here. The presence of dead valves outside the lagoon and possibly of those just inside the entrance is considered to be due to postmortem dispersal. The species is regarded as being restricted to the inner and central lagoon terraces, inhabiting a shallow water environment where a thin layer of filamentous algae often covers the sediment.

## Conclusions

Apart from *Loxoconcha (L.) multiornata* the species of *Loxoconcha* exhibit the pattern of distribution that relates the degree of ornamentation to the energy level of the environment: the finest ornamented form (*L. (L.) indica*) being restricted to a lagoon environment and the more coarsely ornamented species (*L. (L.) gurneyi*) being restricted to the nearshore shelf, more open sea environment. *L. (L.) amygdalanux*, intermediate in the strength of its ornamentation, has a distribution equally shared between the outer part of the lagoon and the shelf environment outside. *L. (Epakroconcha) batei*, although rather coarsely ornamented, is the only species currently placed in this subgenus and in the absence of other species we cannot draw any conclusions from its restriction to a lagoon environment.

## References

**Bate, R. H.** 1971. The distribution of Recent Ostracoda in the Abu Dhabi Lagoon, Persian Gulf. *Bull. Centre Rech. Pau-SNPA* suppl. **5** : 239–256, 3 pls.

**Bate, R. H.** 1973 in Evans, G. *et al.* The oceanography, ecology, sedimentology and geomorphology of parts of the Trucial Coast Barrier Island complex, Persian Gulf. *In:* Purser, B. H. (Ed.) *The Persian Gulf,* 471 pp., Springer-Verlag.

**Bate, R. H. & Sheppard, L. M.** 1980. On *Xestoleberis postangulata* Bate & Sheppard sp. nov. *Stereo-Atlas Ostracod Shells* 7 : 101–106.

**Bate, R. H., Whittaker, J. E. & Mayes, C.** (in press). Marine Ostracoda of the Galapagos Islands and Ecuador. *J. Linn. Soc. zool.*

**Benson, R. H. & Coleman, G. L.** 1963. Recent marine ostracodes from the eastern Gulf of Mexico. *Univ. Kansas Paleont. Contr.* No. **2** : 1–52, pls. 1–8.

**Benson, R. H. & Maddocks, R.** 1964. Recent ostracodes of Knysna Estuary, Cape Province, Union of South Africa. *Univ. Kansas Paleont. Contr.* No. **5** : 1–39, pls. 1–6.

**Bhatia, S. B. & Kumar, S.** 1979. Recent Ostracoda from off Karwar, west coast of India, 173–178, 3 pls. *In:* VII International Symposium on Ostracodes, Beograd.

**Evans, G. *et al.*** 1973. The oceanography, ecology, sedimentology and geomorphology of parts of the Trucial Coast Barrier Island Complex, Persian Gulf, pp. 233–269. *In:* Purser, B. H. (Ed.) *The Persian Gulf,* 471 pp.,Springer-Verlag.

**Gurney, A.** 1979*a*. On *Paijenborchellina alata* Gurney sp. nov. *Stereo-Atlas of Ostracod Shells* **6** : 27–30.

—— 1979*b*. On *Paijenborchellina venosa* Gurney sp. nov. *Stereo-Atlas of Ostracod Shells* **6** : 107–112.

**Hartmann, G.** 1964. Zur Kenntnis der Ostracoden des Roten Meeres. *Kieler Meeresforsch* **20** : 35–127.

—— 1980. Die Ostracoden der Ordnung Podocopida G. W. Müller 1894 der warmtem perierten und subtropisch-tropischen Küstenabschnitte der Süd und Südostküste Australiens. *Mitt. hamb. zool. Mus. Inst.* **77** : 111–204, 15 pls.

**Jain, S. P.** 1978. Recent Ostracoda from Mandvi Beach, West Coast of India. *Bull. Ind. Geol. Assoc.* **11** : 89–139.

**Paik, K. H.** 1976. Rezente Ostracoden aus Oberflächen-sedimenten des Persischen Golfs und des Golfs von Oman. *Diss. Univ. Kiel,* 196 pp.

**Paik, K. H.** 1977. Regionale Untersuchungen zur Verteilung der Ostracoden im Persischen Golf und in Golf von Oman. *'Meteor' Forsch.-Ergebnisse,* No. **28** : 37–76.

**Razzaq, S.** 1979. A preliminary investigation of the marine benthic microfauna of Kuwait. *Kuwait Institute for Scientific Research,* 91 pp., 3 pls.

**Swain, F. M.** 1955. Ostracoda of San Antonio Bay, Texas, *J. Paleont.* **29** : 561–646, pls. 59–64.

Manuscript accepted for publication 27 February 1981